Methods: 20 postero-anterior radiographs of both hands of HOA patients (covering HOA radiographic spectrum) obtained at random from a trial were scored twice by 10 experienced readers at a 15-days interval. Readers were instructed to score the KL (grades: 0-4), using the score as detailed by Kallman [1], and their own view of KL grades. No preliminary training session. During 1st session they also scored joint space narrowing (JSN) and osteophytes (O) (0-4). (Distal (DIP), proximal interphalangeal (PIP), metacarpophalangeal (MCP), scapho-trapezial and trapeziometacarpal joints (16 joints) of one hand selected at random were scored. 8 of the 10 readers (the 2 designers of the KLSSA excluded) were then randomized in 2 groups using the KLSSA or not to score again twice the radiographs, the 4 readers without the KLSSA serving as control group (training effect assessment). The KLSSA combines various amounts of JSN (0-4) and O (0-4) to define KL grades. It shows as a Table, accompanied by HOA images to illustrate the grading. Radiographs were numbered 1-20 at random for each session.
Statistics: Intra-class correlation coefficient with 95% confidence interval (CI) for inter- and intraobserver precision; Bland-Altman graphical method for intraobserver precision.
Results: Results for interobserver reproducibility appear in the table.

	4 readers randomized to score without the KLSSA ICC [CI 95%]	4 readers randomized to score with the KLSSA ICC [CI 95%]
Interobserver reproducibility (1st reading) 1st turn before KLSSA use		
Total osteophytes score (0-64)	0.66 [0.41-0.84]	0.50 [0.25-0.68]
Total JSN score (0-64)	0.47 [0.27-0.68]	0.58 [0.34-0.78]
Toal KL score (0-64)	0.51 [0.26-0.72]	0.41 [0.20-0.64]
Interobserver reproducibility (3rd reading) 2nd turn using or not KLSSA		
Total KL score (0-64)	0.48 [0.25-0.68]	0.79 [0.59-0.89]

KLSSA: KL scoring system aid.

Interobserver precision improved in the group using the KLSSA. No training effect was observed. Intra-observer reproducibility improved for the readers not using the KLSSA (0.87 to 0.95) and almost all those using it (0.57 to 0.89). One reader's precision decreased.
Conclusions: Interobserver reproducibility of KL radiological grading in HOA was improved by the proposed KLSSA which could help for case definition or radiographic progression assessment in future trials or epidemiological studies. Further work is needed to assess longitudinal reproducibility of KL scoring with this system.
Acknowledgements: This work was made possible, thanks to an unrestricted educational grant from Servier Lab.

Reference

[1] Kallman. AR 1989;32:1585-91.

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RAPID MULTI-PLANAR ASSESSMENT OF ARTICLAR CARTILAGE USING HIGH ISOTROPIC RESOLUTION MAGNETIC RESONANCE IMAGING

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Purpose: Balanced steady-state free-precession (SSFP) sequences can be used to evaluate articular cartilage and other joint structures that can be sources of pain in patients with osteoarthritis. At our institution, we have developed a SSFP sequence with high isotropic resolution using alternating repetition time (ATR) fat-water separation and a radial k space trajectory called vastly undersampled isotropic projection reconstruction (VIPR). This study was performed to compare VIPR-ATR with other three-dimensional magnetic resonance imaging (MRI) sequences for evaluating the articular cartilage of the knee joint.
Methods: An MRI examination of the knee joint was performed on 7 asymptomatic volunteers and 3 patients with osteoarthritis using a 3 Tesla scanner (GE Healthcare, Waukesha, WI) and an 8-channel phased-array extremity coil. All MRI examinations consisted of the following sequences performed in the sagittal plane: intermediate-weighted FSE-Cube (0.6 mm x 0.6 mm x 0.6 mm voxel size and 5 minute scan time), IDEAL-GRASS (0.4 mm x 0.7 mm x 1.0 mm voxel size and 5 minute scan time), IDEAL-SPGR (0.4 mm x 0.7 mm x 1.0 mm voxel size and 5 minute scan time), VIPR-ATR (0.4 mm x 0.4 mm x 1.2 mm effective voxel size with 3 slice averaging of 0.4 mm isotropic images in each dimension and 5 minute scan time), and high resolution (HR) VIPR-ATR (0.3 mm x 0.3 mm x 1.0 mm effective voxel size with 3 slice averaging of 0.3 mm isotropic images in each dimension and 8 minute scan time). Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) efficiency measurements normalized to voxel volume were performed on all MRI examinations. Paired t-tests were used to compare differences in normalized SNR and CNR efficiency values between sequences. Two musculoskeletal radiologists independently reviewed all MRI examinations and ranked the sequences based upon the following subjective measures of image quality: 1) tissue contrast, 2) clarity of articular surface, 3) cartilage lesion conspicuity, and 4) overall assessment of articular cartilage.
Results: VIPR-ATR and HR VIPR-ATR produced high quality multi-planar images of the knee joint with bright synovial fluid following a single acquisition (Figure 1). VIPR-ATR and HR VIPR-ATR had similar ($p=0.08$-0.26) normalized cartilage SNR efficiency as FSE-Cube and IDEAL-SPGR and significantly higher ($p<0.05$) normalized cartilage SNR efficiency than IDEAL-GRASS. VIPR-ATR and HR VIPR-ATR had significantly higher ($p<0.05$) normalized synovial fluid SNR efficiency than FSE-Cube, IDEAL-GRASS, and IDEAL-SPGR. VIPR-ATR and HR VIPR-ATR had significantly higher ($p<0.05$) normalized CNR efficiency between cartilage and synovial fluid than FSE-Cube, IDEAL-GRASS, and IDEAL-SPGR, but significantly lower ($p<0.05$) normalized CNR efficiency between cartilage and bone marrow than FSE-Cube and IDEAL-SPGR. On subjective analysis, HR VIPR-ATR followed by VIPR-ATR had the highest ranks for tissue contrast, clarity of articular surface, cartilage lesion conspicuity, and overall assessment of articular cartilage (Figure 2).

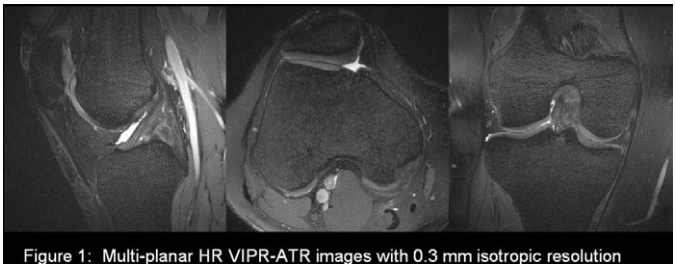

Figure 1: Multi-planar HR VIPR-ATR images with 0.3 mm isotropic resolution

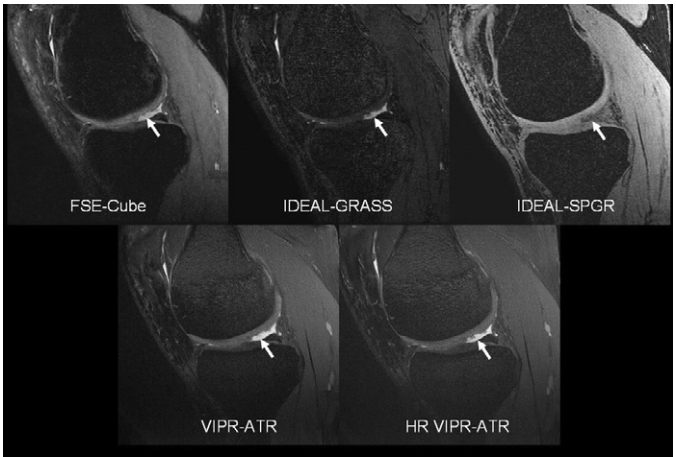

Figure 2: Appearance of a superficial partial-thickness cartilage lesion (arrows) on multiple high resolution cartilage imaging sequences

Conclusions: VIPR-ATR produces high quality multi-planar images of the knee joint with 0.4 mm isotropic resolution in 5 minutes and 0.3 mm isotropic resolution in 8 minutes. In contrast, the DESS sequence currently used in the Osteoarthritis Initiative to evaluate articular cartilage has a voxel size of 0.4 mm × 0.5 mm × 0.7 mm and a scan time of more than 10 minutes. VIPR-ATR images have high cartilage SNR efficiency and high contrast between cartilage and adjacent joint structures which makes them well suited for detecting cartilage lesions and for measuring cartilage volume. Since SSFP tissue contrast is also useful for evaluating menisci, ligaments, and osseous structures, VIPR-ATR may be used in osteoarthritis research studies to provide rapid "whole-organ" joint assessment and cartilage volume analysis.